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Effects of Three Livestock Grazing Regimes on the Nesting Ecology of Birds in Shortgrass Prairie at the Rita Blanca National Grassland

FINAL REPORT

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EFFECTS OF THREE LIVESTOCK GRAZING REGIMES ON THE NESTING ECOLOGY OF BIRDS IN SHORTGRASS PRAIRIE AT THE RITA BLANCA NATIONAL GRASSLAND

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INTRODUCTION

Shortgrass prairie ecosystems evolved under tremendous grazing pressure by herbivores such as bison (*Bison bison*), black-tailed prairie dogs (*Cynomys ludovicianus*), and to a lesser extent elk (*Cervus elaphus*) and pronghorn (*Antilocapra americana*). These species, particularly the bison and black-tailed prairie dog, have been largely removed from their former ranges in shortgrass prairie habitats and replaced with domestic livestock. Milchunas et al. (1988) suggested that shortgrass prairie ecosystems may have changed very little since the introduction of livestock because bison were simply replaced by cattle as the primary large herbivore. However, ecological differences between cattle and bison coupled with other changes to the landscape, such as the installation of fences, suppression of fires, and implementation of agricultural practices may have altered shortgrass prairie ecosystems. Free ranging bison probably influenced shortgrass prairie ecosystems differently than present-day cattle that are confined by fences. Unfortunately, there is no way to accurately determine the historic (pre-livestock) composition and structure of avian communities in these shortgrass prairie ecosystems. Our goal was to determine the present avian community composition and structure in a shortgrass prairie ecosystem and determine the differential effects of three grazing regimes on the nesting ecology of this avian community. Few studies have examined the effects of livestock grazing on birds in shortgrass prairie (Wiens 1973, Graul 1975, Maher 1979, Ryder 1980), and to our knowledge, none have specifically studied the differential effects of various grazing regimes. Saab et al. (1995) provides an excellent review of the ornithological literature on the effects of livestock grazing on Neotropical migrants.

STUDY AREA

Our research was conducted at the Rita Blanca National Grassland located in the northern portion of the Texas panhandle. The Rita Blanca National Grassland is contiguous with the Kiowa National Grassland and both are administered by the Cibola National Forest. The two grasslands constitute approximately 100,000 ha and are partially contained within New Mexico, Texas, and Oklahoma. Our study sites were located within Dallam County, Texas approximately 24 km east of the town of Texline.

Much of the Rita Blanca National Grassland (hereafter referred to as grassland) was plowed for cultivating crops prior to the Great Plains dust bowl, and as a consequence much of the *A* horizon soils have been lost or redistributed through erosion. The federal government purchased the land in the 1930s and ceased cultivating it in favor of restoring native vegetation. Today, the grassland has been re-vegetated with plant species that are indicative of the native shortgrass prairie ecosystem. Common plant species include broom snakeweed (*Gutierrezia sarothrae*), blue grama (*Bouteloua gracilis*), buffalograss (*Buchloe dactyloides*), wooly Indian-wheat (*Plantago purshii*), prairie coneflower (*Ratibida columnifera*), and green verbena (*Verbena wrightii*). The grassland is grazed by privately owned cattle under paid permits, and several different grazing systems (e.g., cell grazing) are employed within the grassland.

We located and marked eight 16.2 ha study plots within five management units on the grassland. There were two study plots located in each of four grazing regimes. Plots 0A and 0B were located in unit 32 (373 ha) which had not been grazed since 1992, and was not grazed for the duration of our study. Plots 1A and 1B are located in unit 34 (741 ha) which was grazed continuously during the growing season (16 May to 15 October). Plots 4A and 4B are located in units 24 (398 ha) and 25 (166), respectively. These units were being managed using a four-pasture cell grazing system, where cattle are moved between pastures approximately every 30 days. Plots 8A and 8B are located in unit 23 (774 ha). This unit was managed as an eight-pasture cell grazing system, where cattle are moved between pastures approximately every seven days.

METHODS

Study Design and Basic Statistical Procedures—Two study plots were established within each of four treatment groups (grazing regimes). Data from these plots were used to assess the variation in reproductive, habitat, community based, and insect biomass variables within and among the treatment groups. Continuous variables were compared among treatment groups using univariate analyses-of-variance (ANOVA), blocking by May and June (or May and July for ground cover data) replicates. These replicates correspond to the time periods when point counts were conducted. Post hoc comparisons between treatments were conducted using Least Significant Difference (LSD) tests. Data were stored and manipulated using dBase IV, and all statistical analyses were carried out using the statistical package CSS.

Layout of Study Plots—Each study plot was 402 m by 402 m and covered an area of 16.2 ha. The plots each contained 13 north-south and 13 east-west transect lines set at 33.5-m intervals. A 41-cm long wooden stake was driven into the ground at the intersection of each transect line to identify the 169 grid point locations. These semi-permanently marked grid points aided in nest relocation and provide reference points for conducting vegetation surveys, insect surveys, and point counts. The wooden stakes only protruded from the ground about 10 to 15 cm. All field work for this project was conducted by three temporary, biological technicians that were employed by GMSARC. The technicians were visited and supervised regularly by one of three permanent staff biologists from GMSARC.

Nest Searching and Monitoring—Nests were located through the observation of flushes and behavioral cues such as food, fecal sac, and nesting material carries to and from nests. Nest locations were discretely marked by attaching a brightly colored 2.5-cm square nylon marker to the ground approximately 10 m from the nest. Nests were monitored every 3-4 days until fledging or failure. We followed guidelines outlined by Ralph et al. (1993) to minimize observer-related effects on rates of predation caused by nest monitoring. Data collected at nest sites were be maintained on standardized Nest Check and Nest Record Forms. Each study plot had its own Nest Check Form on which all nest checks for that plot were recorded in the field. Each individual nest had its own Nest Record Form that will be used to enter data into a dBase IV database. Some of the reproductive variables that were recorded include presence/absence of adults, number of eggs (clutch size) and young, number of Brown-headed Cowbird (*Molothrus*

ater) eggs, estimated number of young fledged, and outcome (e.g., successful, depredated, trampled). Several basic nest-site characteristics were measured at each nest, including species of nest substrate, relative nest concealment, nest dimensions, and surrounding vegetation density and height.

Conducting Point Counts—Nine 67-m fixed-radius point counts were conducted in association with each plot once each in May and June. Five of the nine point count centers were located within the boundaries of each plot. In addition, to increase the amount of area sampled and obtain a more representative sample of the entire management unit, two replicates of four 67-m fixed radius point counts were conducted outside the study plot boundaries. The location of these additional point count centers was randomly selected using the center grid point (G6) of each study plot as a reference point. Each replicate of nine point counts (5 inside the plot and 4 outside) was initiated between 15 min post sunrise and 0800 hr and was completed within 120 min. This procedure provided two replicates of 18 point count stations per treatment group (grazing regime). The duration of each point count was 10 min and point count data were maintained on a standardized Point Count Data Form. Individual birds heard or seen during point counts were recorded as singing males, other, or flybys.

Study Plot Vegetation Sampling—Each plot was sampled during late-May and July to determine percent ground cover. Vegetation height and density were sampled in late April, late May, late June, and late July. Twenty randomly selected grid points on each plot were used as reference points for sampling vegetation. The same 20 points were used during each sampling period. Samples were taken at four locations relative to the randomly selected grid point; these being located 1 m north, south, east, and west of the grid point. An aluminum rod of 0.63 cm diameter was held vertically by one person while another counted the number of contacts the vegetation made with the rod within three strata: 0-10 cm, 10-30 cm, and > 30 cm (Wiens 1973). The height of the tallest piece of vegetation within a 1-m radius of the grid point was also recorded. Percent ground cover by vegetation was estimated using ocular tube readings (James and Shugart 1970). Twenty ocular tube readings were made at 5-m intervals along two 50-m perpendicular transects centered on the grid point, yielding a total of 400 ocular tube readings per plot per sampling period.

Insect Sampling—Insects were sampled on each study plot during mid-May, mid-June, and mid-July. Both sides of a 6.3-cm by 7.6-cm step-stake flag were be coated with *Tangle-foot* and placed at the four outermost point count centers (grid points C2, C10, K2, and K10). *Tangle-foot* is a natural insect trapping adhesive that is non-toxic. Two of the flags were oriented east-west, while the remaining two were oriented north-south. Flags were collected between 22 and 26 hours after being placed. Insects adhering to either side of the flag were counted and categorized by taxonomic order and size class (< 2 mm, 2-5 mm, 5-10 mm, and > 10 mm), and recorded on a standardized data form.

RESULTS

Nest Finding and Monitoring—We found and monitored 87 nests of 14 species on and adjacent to our study plots, and at the Thompson Grove Campground where our field crew lived during the field season. Seventeen (19%) of the 87 nests were actually located on our study plots. These included 13 Horned Lark (*Eremophila alpestris*), three Mourning Dove (*Zenaida macroura*), and one Western Meadowlark (*Sturnella magna*) nest. On the ungrazed plots we located two Mourning Dove nests, one Western Meadowlark nest, and one Horned Lark nest. Eight Horned Lark nests were found on season-long, continuously grazed plots, two Horned Lark nests were found on each of the four and eight pasture cell grazing plots. One Mourning Dove nest was located in the eight pasture plots. Table 24 shows the number of successful and unsuccessful nests on each plot. Seventeen (19%) nests were located in the vicinity of our study plots, these included four Chihuahuan Raven (*Corvus cryptoleucus*) nests, three Mourning Dove nests, two Ferruginous Hawk (*Buteo regalis*) nests, two Swainson's Hawk (*Buteo swainsoni*) nests, two Northern Mockingbird (*Mimus polyglottos*) nests, two Western Meadowlark nests, one Loggerhead Shrike (*Lanius ludovicianus*) nest, and one Killdeer (*Charadrius vociferus*) nest. In addition, 54 (62%) nests were located at the Thompson Grove Campground. These included 30 Mourning Dove nests, 10 Northern Mockingbird nests, six Lark Sparrow (*Chondestes grammacus*) nests, four Western Kingbird (*Tyranus verticalis*) nests, and one nest each for Red-tailed Hawk (*Buteo jamaicensis*), Loggerhead Shrike, Cassin's Sparrow (*Aimophila cassinii*), and Barn Swallow (*Hirundo rustica*).

Point Counts—Two-hundred seven birds of six species were recorded at 72 fixed-radius point count centers. Two replicate surveys were conducted on the eight study plots within the four treatment groups during May and June. Forty-nine percent and 40% of the birds observed were Horned Larks and Western Meadowlarks, respectively (Table 1). Sixty birds, the highest number recorded for any treatment group, were observed on the eight cell rotational grazing treatment, while the lowest number, 47, was observed on the four cell and the season long continuously grazed treatments. All treatments contained at least four bird species, except the season long continuously grazed treatment which contained only two species.

Analysis of Variance (ANOVA) tables and all-way comparison of treatment tables are presented below for all species of birds combined. Three species of birds were recorded in sufficient numbers on the plots to allow comparison of treatments within the species. These three species were, in order of abundance: Horned Lark, Western Meadowlark, and Grasshopper Sparrow. Tables for these three species are also presented.

Table 2. ANOVA table for all species combined. "Grazing" are the four grazing treatments. Treatments were blocked on May and June replicates.

Effect	SS	df	MS	F	p
(A): Grazing	28.69	3	9.56	.24	.87
(B): Replicate	3.06	1	3.06	.08	.78
A x B	163.69	3	54.56	1.36	.32
Within	321.50	8	40.19		

Table 3. Post-hoc comparisons for all species combined, using LSD test. Mean number of birds per plot is given in the first column. The remaining cells contain the p value for the comparison between treatments.

Mean No. Birds		Ungrazed	4 cell	8 cell	S-c grazed
13.25	Ungrazed	--	.74	.71	.74
11.75	4 cell	.74	--	.49	1.00
15.00	8 cell	.71	.49	--	.49
11.75	S-c grazed	.74	1.00	.49	--

Table 4. ANOVA table for Horned Lark (presented as in Table 2).

Effect	SS	df	MS	F	p
(A): Grazing	104.75	3	34.92	3.10	.09
(B): Replicate	.25	1	.25	.02	.86
A x B	32.75	3	10.92	.97	.45
Within	90.00	8	11.25		

Table 5. Post-hoc comparisons among treatments for Horned Larks, using LSD test (presented as in Table 3).

Mean No. Birds		Ungrazed	4 cell	8 cell	S-c grazed
3.25	Ungrazed	--	.43	.18	.02
5.25	4 cell	.43	--	.55	.07
6.75	8 cell	.18	.55	--	.18
10.25	S-c grazed	.02	.07	.18	--

Table 6. ANOVA table for Western Meadowlark (presented as in Table 2).

Effect	SS	df	MS	F	p
(A): Grazing	90.25	3	30.08	2.17	.17
(B): Replicate	1.00	1	1.00	.07	.78
A x B	67.50	3	22.50	1.62	.26
Within	111.00	8	13.88		

Table 7. Post-hoc comparisons for Western Meadowlarks, using LSD test (presented as in Table 3).

Mean No. Birds		Ungrazed	4 cell	8 cell	S-c grazed
7.25	Ungrazed	--	.33	1.00	.06
4.50	4 cell	.33	--	.33	.29
7.25	8 cell	1.00	.33	--	.06
1.50	S-c grazed	.06	.29	.06	--

Table 8. ANOVA table for Grasshopper sparrow (as in Table 2).

Effect	SS	df	MS	F	p
(A): Grazing	9.25	3	3.08	1.45	.30
(B): Replicate	.25	1	.25	.12	.74
A x B	1.25	3	.42	.20	.89
Within	17.00	8	2.13		

Table 9. Post-hoc comparisons of Grasshopper Sparrow, using LSD test (as in Table 3).

Mean No. Birds		Ungrazed	4 cell	8 cell	S-c grazed
1.50	Ungrazed	--	.80	.26	.18
1.75	4 cell	.80	--	.18	.13
.25	8 cell	.26	.18	--	.80
.00	S-c grazed	.18	.13	.80	--

While no significant patterns emerge from the comparison of all species combined (Table 2), individual species did vary in relative abundance according to treatment type. Horned Larks were most abundant in the continuously grazed treatment, differing significantly ($p=0.02$) from the ungrazed treatment and nearly so ($p=0.07$) from the 4-cell treatment. Differences in the 8-cell vs. 4-cell and the ungrazed vs. 8-cell were not significant ($p=0.55$ and 0.18, respectively). Western Meadowlarks were most abundant in ungrazed and 8-cell treatments, which differed in

abundance from the continuously grazed treatment at a level very near significance (p=0.06, Table 7). Relative abundance in the 4-cell treatment was intermediate. The small sample of Grasshopper Sparrows in the counts failed to reveal significant differences between treatments, although the areas with the greatest numbers of Grasshopper Sparrows were the 4-cell and ungrazed treatments (Table 9).

Insect Sampling—Insects were sampled at four locations within each of the eight plots during May, June, and July (Table 10). An index to insect biomass was calculated for each plot based on the number and size of insects captured. The mean biomass index for May, June, and July on the eight plots was 48.8, 151.8, and 10.6, respectively. Ungrazed plots contained the highest mean biomass index of 83.4, while four cell rotationally grazed plots contained the lowest mean index of 62.4.

Table 11. ANOVA table for insect biomass index (presented as in Table 2). Treatments were blocked on May and June replicates.

Effect	SS	df	MS	F	p
(A): Grazing	2366.51	3	788.84	.65	.61
(B): Month	40491.51	1	40491.51	33.48	.00
A x B	5434.06	3	1811.35	1.50	.29
Within	9676.05	8	1209.51		

Table 12. Post-hoc comparisons of insect biomass index, using LSD test (presented as in table 3).

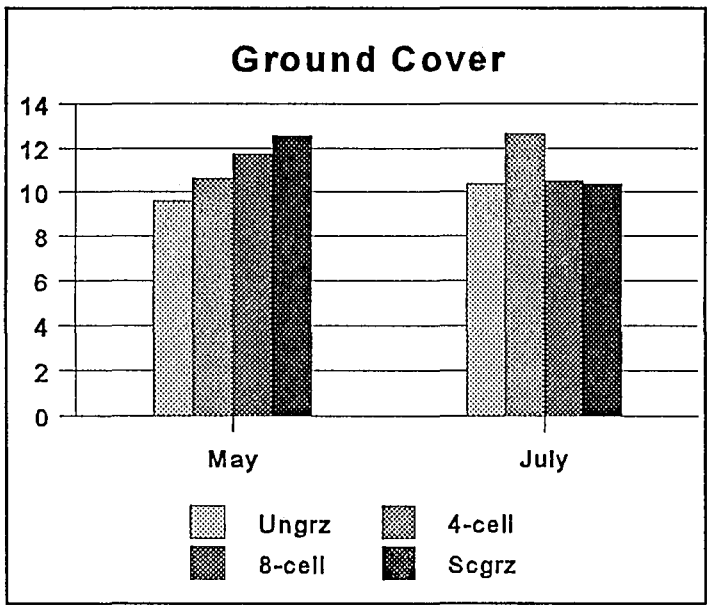
Mean Index		Ungrazed	4 cell	8 cell	S-c grazed
118.43	Ungrazed	--	.21	.43	.38
84.90	4 cell	.21	--	.61	.69
97.95	8 cell	.43	.64	--	.88
95.20	S-c grazed	.38	.69	.88	--

None of the differences in the insect biomass index were significant between treatments (Table 11).

Vegetation Sampling—We estimated the percent ground cover by herbaceous vegetation using 400 ocular tube readings per plot during May and July. Although the percent coverage of vegetation did change slightly from May to July on some plots, the overall mean percent coverage was 56% during both sampling periods (Table 13).

An index to the vegetation density was determined on each plot during April, May, June, and July.

The index represents the average number of vegetation contacts within several height strata on a 0.63 cm diameter rod held vertically at 80 locations within each plot (Table 14). The overall mean number of contacts (≤30 cm) for all eight plots was 7.6. The highest number of mean contacts, 8.7, occurred on the ungrazed plots, while the lowest number, 5.9, occurred on season long continuously grazed plots. Maximum vegetation height (cm) was determined at 20 randomly selected grid points during each month on each of the plots (Table 15). The mean maximum vegetation height was highest at 42.4 cm on the ungrazed plots and lowest at 23.2 cm on the season long continuously grazed plots. The overall mean maximum vegetation height was 32.7 cm.



Ungrz = ungrazed
4-cell = 4-cell rotation
8-cell = 8-cell rotation
Scgrz= season-long continuous grazing

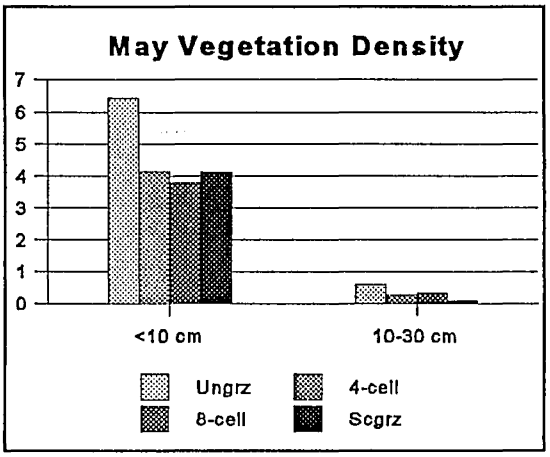
Table 14. Anova table for mean ground cover index. "Grazing" are the four grazing treatments. Treatments were blocked on May and July replicates.

Effect	SS	df	MS	F	p
(A): Grazing	6.33	3	2.11	1.74	.24
(B): Replicate	.16	1	.16	.13	.72
A x B	11.31	3	3.77	3.11	.09
Within	9.71	8	1.21		

Table 15. Post-hoc comparisons among treatments for mean ground cover index, using LSD test. Mean ground cover index per plot is given in the first column. The remaining cells contain the p value for the comparison between treatments.

Mean Gr. Cov. Index		Ungrazed	4 cell	8 cell	S-c grazed
9.98	Ungrazed	--	.07	.18	.11
11.63	4 cell	.07	--	.53	.74
11.11	8 cell	.18	.53	--	.75
11.36	S-c grazed	.11	.74	.75	--

The ungrazed treatment is almost significantly different from 4-cell, but the other three are not very different from one another.



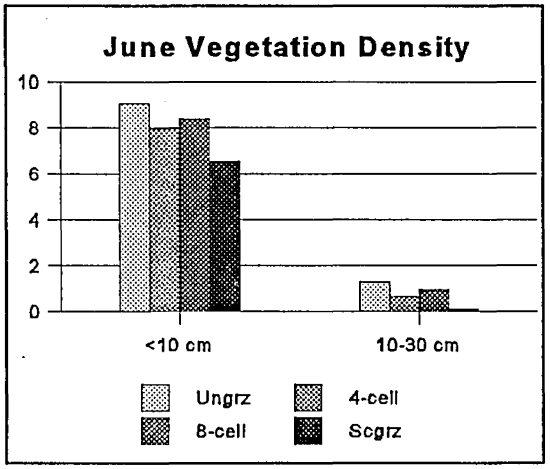


Table 18. ANOVA table for vegetation density index in the <10 cm stratum in May and June, the months in which point counts were conducted (presented as in Table 2).

Effect	SS	df	MS	F	p
(A): Grazing	12.50	3	4.17	.75	.56
(B): Month	45.56	1	45.56	8.17	.02
A x B	3.09	3	1.03	.19	.90
Within	44.60	8	5.58		

Table 19. Post-hoc comparisons of vegetation density index in the <10 cm stratum in May and June, using LSD test (presented as in Table 3).

Mean Veg. Dens. Index		Ungrazed	4 cell	8 cell	S-c grazed
7.75	Ungrazed	--	.35	.35	.19
6.08	4 cell	.35	--	.94	.67
6.09	8 cell	.35	.94	--	.67
5.34	S-c grazed	.18	.67	.67	--

No differences between treatments are significant, but the 8-cell and 4-cell treatments are the most similar while the ungrazed and continuously grazed treatments are the most different.

Table 20. ANOVA table of vegetation density index in the 10-30 cm stratum in May and June, using LSD test (presented as in Table 2).

Effect	SS	df	MS	F	p
(A): Grazing	1.47	3	.49	2.49	.13
(B): Month	.70	1	.70	3.57	.09
A x B	.29	3	.10	.48	.71
Within	1.57	8	.20		

Table 21. Post-hoc comparisons of vegetation density index in the 10-30 cm stratum, using LSD test (presented as in Table 3).

Mean Veg. Dens. Index		Ungrazed	4 cell	8 cell	S-c grazed
0.94	Ungrazed	--	.17	.37	.03
0.46	4 cell	.17	--	.60	.28
0.64	8 cell	.37	.60	--	.12
0.10	S-c grazed	.03	.28	.12	--

The vegetation density index is significantly different (p=0.03) between the ungrazed and

continuously grazed treatments. No other treatment types differed significantly, although differences between treatments were generally greater than in the <10 cm stratum.

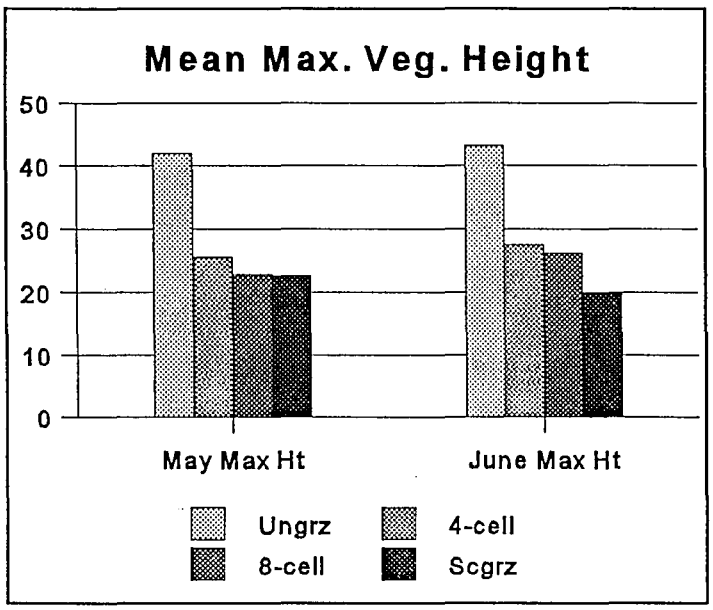


Table 22. ANOVA table of mean maximum vegetation height during May and June (presented as in table 2).

Effect	SS	df	MS	F	p
(A): Grazing	1082.90	3	360.97	8.00	.01
(B): Month	3.84	1	3.84	.09	.77
A x B	18.55	3	6.18	.14	.93
Within	360.88	8	45.11		

Table 23. Post-hoc comparisons of mean maximum vegetation height during May and June, using LSD test (presented as in Table 3).

Mean Max. Veg. Ht.		Ungrazed	4 cell	8 cell	S-c grazed
42.55	Ungrazed	--	.01	.01	.00
26.54	4 cell	.01	--	.68	.29
24.50	8 cell	.01	.68	--	.51
21.18	S-c grazed	.00	.30	.51	--

Mean maximum vegetation height in the ungrazed treatment was very significantly different from that in the 4-cell, 8-cell, and continuously grazed treatments (p=0.01, 0.01, and

<0.01, respectively). This suggests that Western Meadowlarks are not keying in on maximum vegetation height since ungrazed and 8-cell treatments showed equal abundance. Likewise, Horned Larks are not keying in on maximum vegetation height since relative abundance was similar on ungrazed and 4-cell treatments. In terms of maximum vegetation height, 4-cell, 8-cell, and continuously grazed treatments do not differ significantly.

Significant vegetation height and density differences between treatments at the lowest stratum, <10 cm, are lacking. Differences between treatments at the middle stratum are more pronounced, while differences between treatments at the highest stratum (maximum vegetation height) are the most pronounced. This makes biological sense given that grass grows from the ground up while cattle graze it from the top down. Grazing therefore has the greatest impact on the higher vegetation strata. These results suggest that our vegetation sampling techniques are providing a useful measure of grazing effects on vegetation height and density.

Additional Discussion and Conclusions

Few passerine nests and birds were observed in the contiguous shortgrass prairie habitat where are plots are located. The nesting density in these areas may typically be low. However, we believe the severe drought that occurred during portions of 1995 and 1996 adversely impacted avian populations. From January through May 1996, this region received only 1.03" (2.6 cm) of precipitation, 79% less than the 30 year average of 4.92" (12.6 cm) for this same time period (National Weather Service). The rain that fell in June and July of 1996 while we were conducting our field work probably came too late to supply potentially breeding birds with adequate vegetative cover and food (insects). As evidence of this, Lark Buntings near Rita Blanca National Grassland were nearly absent from U.S. Fish and Wildlife Service Breeding Bird Survey Routes in areas were they had been abundant in previous years (J. Shackford, personal communication). In addition, the severe drought caused ranchers to alter their typical grazing schedules, thus, making 1996 anomalous from a weather and grazing standpoint.

While the small sample of nests did not allow for comparisons of nest success between treatment types, we believe the other data appear sound, and the point count data provide some useful information for land managers wishing to enhance habitat for grassland bird species. The grazing regime (or lack thereof) in use does influence the relative abundance of passerine species utilizing shortgrass prairie habitat. The above data provide some specifics on this influence for several common species on the Rita Blanca National Grassland. Not surprisingly, if managing for diversity of grassland bird species is a priority, then providing the mosaic of habitats produced by the patterning of varied grazing regimes across a landscape will be important because responses to particular regimes are species-specific and may be opposite for different species (for example, Western Meadowlark vs. Horned Lark). Several shortgrass species of high conservation concern were not well represented or did not occur at all on our study plots, so parallel information for them is lacking. As mentioned above, it is not known what effect the anomalous weather conditions of 1996 had on our results.

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Table 1. Species and number of individuals observed during two point count replicates within four treatments during May and June 1996 at Rita Blanca National Grassland, TX.

SPECIES	UNGRZ	4CELL	8CELL	SCGRZ	TOTAL
Horned Lark	13	21	27	41	102
Western Meadowlark	29	18	29	6	82
Grasshopper Sparrow	6	7	1	0	14
Mourning Dove	4	0	2	0	6
Common Nighthawk	1	1	0	0	2
Killdeer	0	0	1	0	1
TOTAL	53	47	60	47	207

UNGRZ = Ungrazed
4CELL = Four cell rotational grazing
8CELL = Eight cell rotational grazing
SCGRZ = Season-long continuous grazing

Table 10. Insect biomass indices for May, June, and July 1996 within eight plots and four treatments at Rita Blanca National Grassland, TX.

PLOT	MAY	JUNE	JULY	MEAN
0A	59.8	164.8	14.4	79.7
0B	50.2	198.9	12.4	87.2
4A	42.9	119.3	4.6	55.6
4B	88.7	107.3	11.4	69.1
8A	33.8	134.5	16.4	61.6
8B	33.5	190.0	9.2	77.6
1A	42.7	204.3	4.5	83.8
1B	38.9	94.9	12.1	48.6
MEAN	48.8	151.8	10.6	70.4

0A and 0B = plots A and B within ungrazed treatment
4A and 4B = plots A and B within four cell rotational grazing treatment
8A and 8B = plots A and B within eight cell rotational grazing treatment
1A and 1B = plots A and B within season-long continuous grazing treatment

Table 13. Percent ground cover by herbaceous vegetation within eight plots and four treatments during May and July 1996 at Rita Blanca National Grassland, TX.

PLOT	MAY	JULY	MEAN
0A	44	49	46
0B	52	55	53
4A	55	65	60
4B	53	61	57
8A	56	52	54
8B	62	53	57
1A	71	60	65
1B	54	51	52
TOTAL	56	56	56

0A and 0B = plots A and B within ungrazed treatment
4A and 4B = plots A and B within four cell rotational grazing treatment
8A and 8B = plots A and B within eight cell rotational grazing treatment
1A and 1B = plots A and B within season-long continuous grazing treatment

Table 14. Vegetation density index during 1996 at eight plots within four treatments at Rita Blanca National Grassland, TX.

PLOT	APRIL	MAY	JUNE	JULY	MEAN
0A	10.1	7.3	11.2	6.9	8.9
0B	9.8	7.7	8.7	8.1	8.6
4A	10.5	3.1	7.3	8.6	7.4
4B	9.5	5.7	10.0	8.5	8.4
8A	8.7	1.9	6.2	6.4	5.8
8B	11.5	6.3	12.4	11.2	10.3
1A	6.0	3.6	9.0	8.5	6.8
1B	6.6	4.8	4.2	5.0	5.1
MEAN	9.1	5.0	8.6	7.9	7.6

0A and 0B = plots A and B within ungrazed treatment
4A and 4B = plots A and B within four cell rotational grazing treatment
8A and 8B = plots A and B within eight cell rotational grazing treatment
1A and 1B = plots A and B within season-long continuous grazing treatment

Table 15. Mean maximum vegetation height (cm) at eight plots within four treatments at Rita Blanca National Grassland, TX.

PLOT	APRIL	MAY	JUNE	JULY	MEAN
0A	37.8	40.7	36.1	41.9	39.1
0B	49.2	42.7	47.1	43.8	45.7
4A	38.3	23.5	25.5	37.7	31.2
4B	46.5	27.6	29.5	48.4	38.0
8A	32.1	14.2	16.9	36.4	24.9
8B	40.4	31.5	35.3	36.9	36.0
1A	25.1	22.9	22.5	28.2	24.7
1B	18.9	23.2	17.3	27.9	21.8
MEAN	36.0	28.3	28.8	37.6	32.7

0A and 0B = plots A and B within ungrazed treatment
4A and 4B = plots A and B within four cell rotational grazing treatment
8A and 8B = plots A and B within eight cell rotational grazing treatment
1A and 1B = plots A and B within season-long continuous grazing treatment

Table 24. Number of successful/unsuccessful/outcome unknown nests on each of eight study plots within 4 treatment groups.

Plot	Horned Lark	Western Meadowlark	Mourning Dove	Total
0A	none	none	0/1/1	0/1/1
0B	1/0/0	0/1/0	none	1/1/0
1A	1/3/0	none	none	1/3/0
1B	0/4/0	none	none	0/4/0
4A	0/2/0	none	none	0/2/0
4B	none	none	none	none
8A	0/1/0	none	0/1/0	0/2/0
8B	0/1/0	none	none	0/1/0
Total	2/11/0	0/1/0	0/2/1	2/14/1

0A and 0B are ungrazed plots
1A and 1B are season-long continuously grazed plots
4A and 4B are 4-cell rotation grazing plots
8A and 8 B are 8-cell rotation grazing plots